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ANNEX 8

DATA ANNEX: INDIA

FROM IDEAS TO ACTION: CLEAN ENERGY SOLUTIONS FOR ASIA TO ADDRESS CLIMATE CHANGE

June 2007
This report was produced for the United States Agency for International Development.
It was prepared by International Resources Group (IRG).

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DISCLAIMER
The authors' views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

India country profile – Quantitative data

NOTE: This compilation is mostly based on regional datasets and to a limited extent on country-level primary data. While regional datasets offer the advantage of data consistency (definitions and units) and higher data quality, they are often outdated relative to national country data sets. Further, the assumptions made by regional research institutes to model future trends may vary from those adopted by national government institutes. As such, the data presented here is best used to evaluate broad differences between countries and obtain an overview of future trends, rather than provide specific information at a particular point in time.

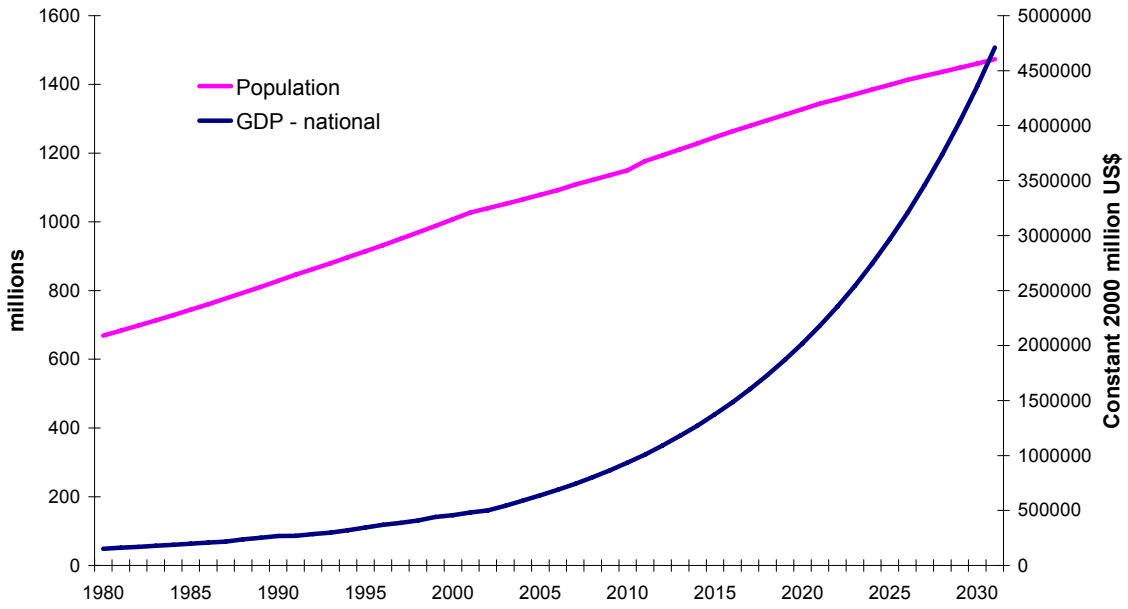
Section 1. Introduction

a) General data

Population (2005) #	1080264388
Country area (km²) #	3166944
GDP - per capita (constant 2000 US$) [2005] ##	586
Percentage of total population living in urban areas (%)#	28.1
Percentage of households connected to the grid (electricity) [%]#	44.4
* Urbanization level is expected to reach 41.4 % by 2030 #	

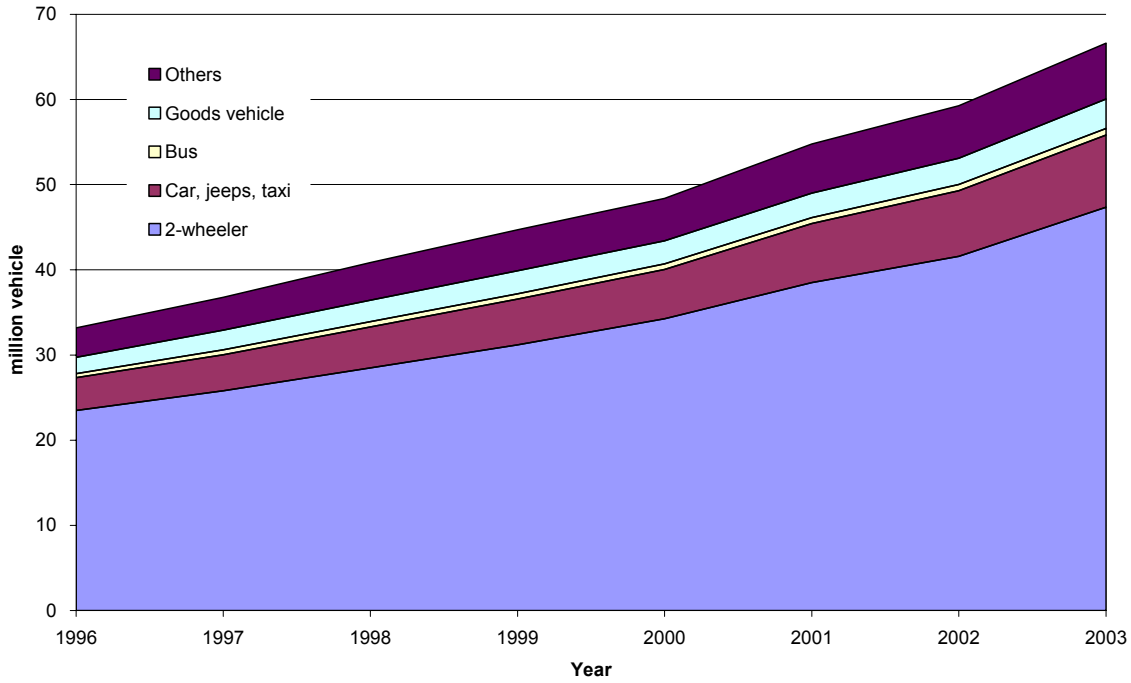
Source: # RECIPES (2006), ## The Energy Research Institute, India (2006)

b) Growth in Population and GDP



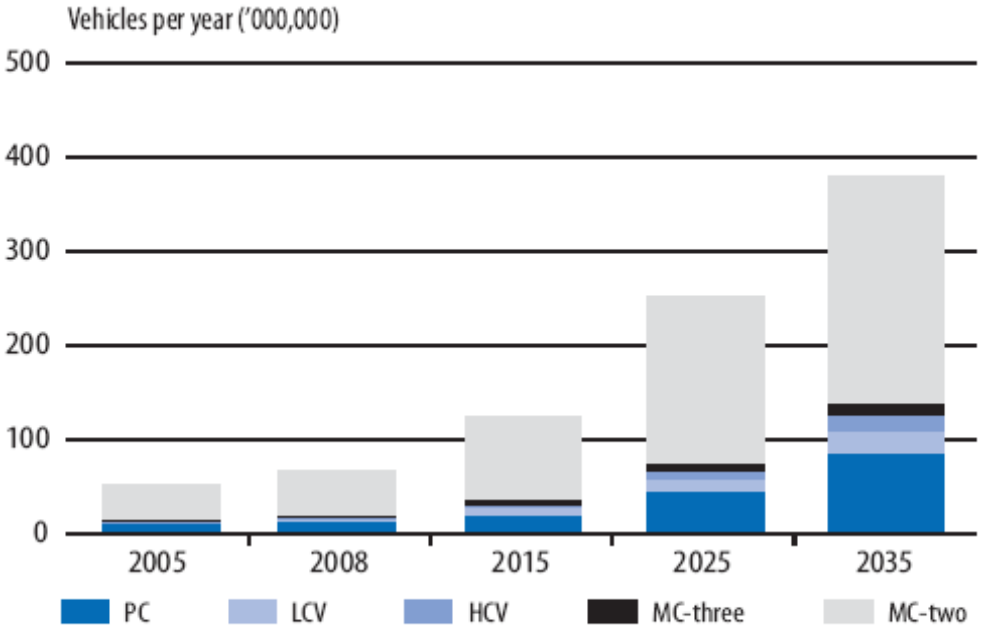
Source: TERI (2006)

c) Number of Vehicles in India



Source: ADB (2006b).

a. Forecasts for Growth in the Number of Motor Vehicles in India

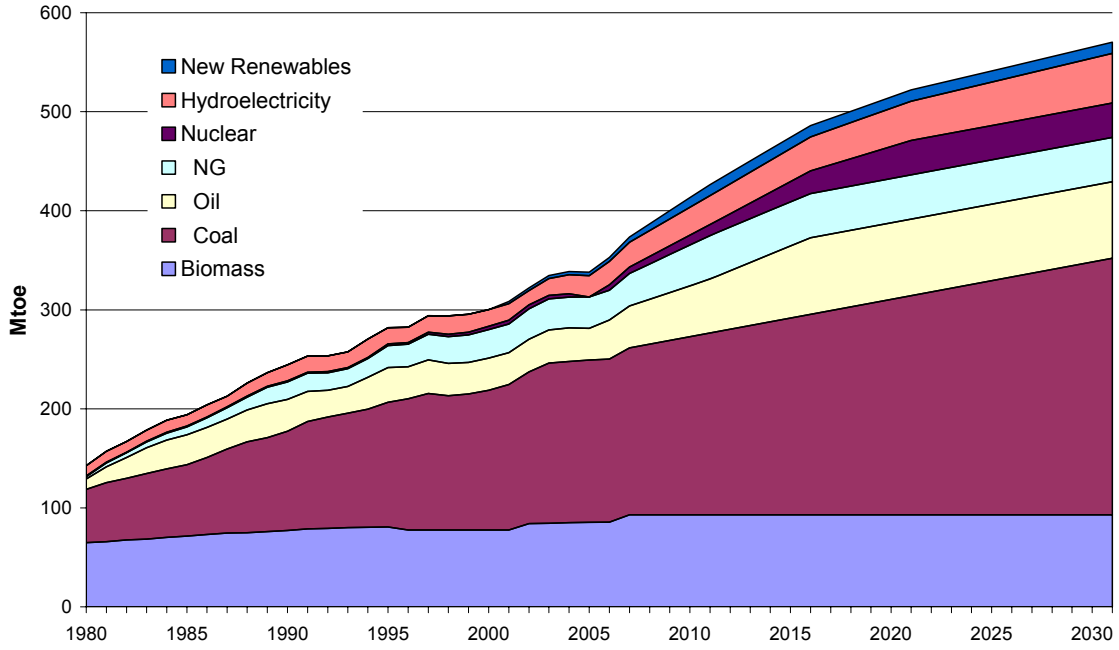


HCV = heavy commercial vehicle; LCV = light commercial vehicle; MC-three = three-wheeled vehicle with a motorcycle engine; MC-two = two-wheeled motorcycle; PC = private car

Source: ADB (2006b).

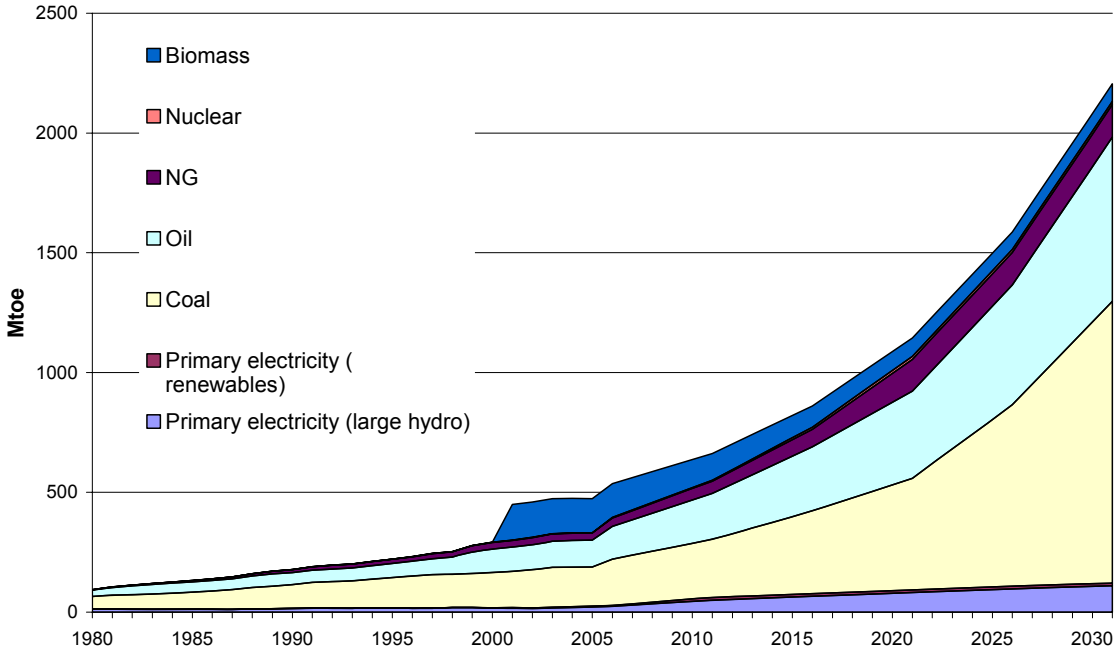
Section 2. Current status of energy supply and demand

d) Domestic energy supply by source



Source: TERI (2006)

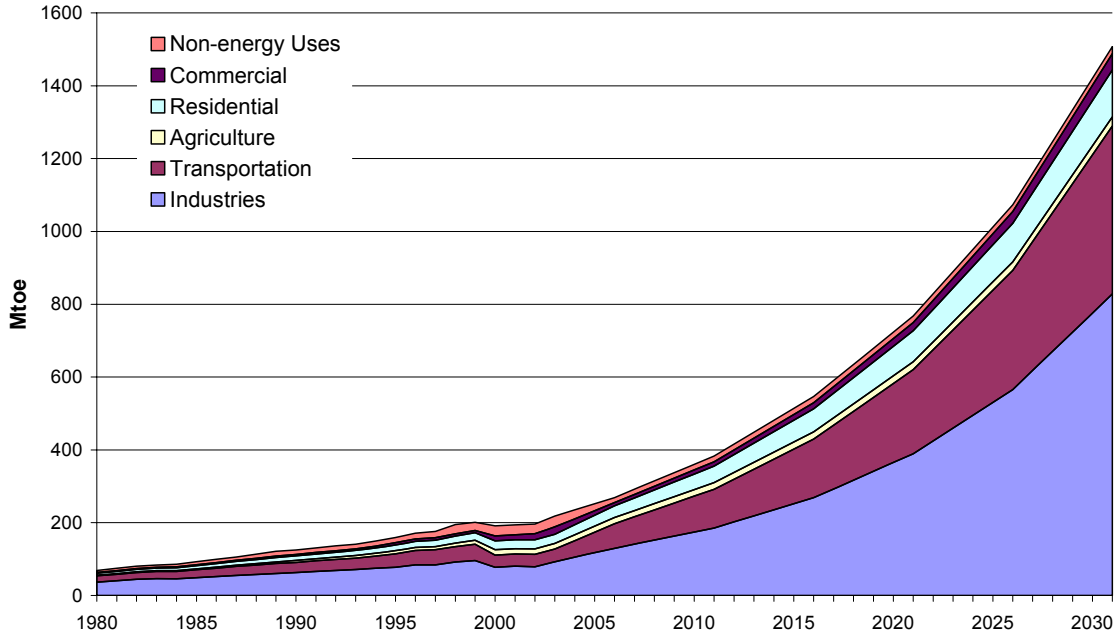
e) Total final energy demand by Source[1]



Source: TERI (2006).

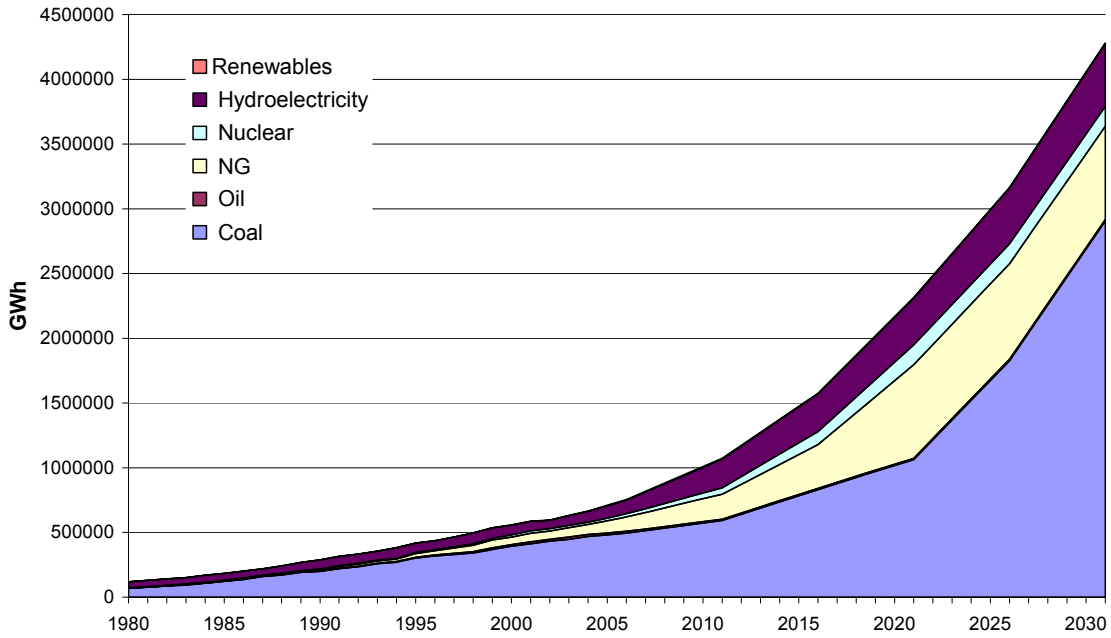
[1] Past time series data on biomass consumption is not available

f) Total final energy demand by sector



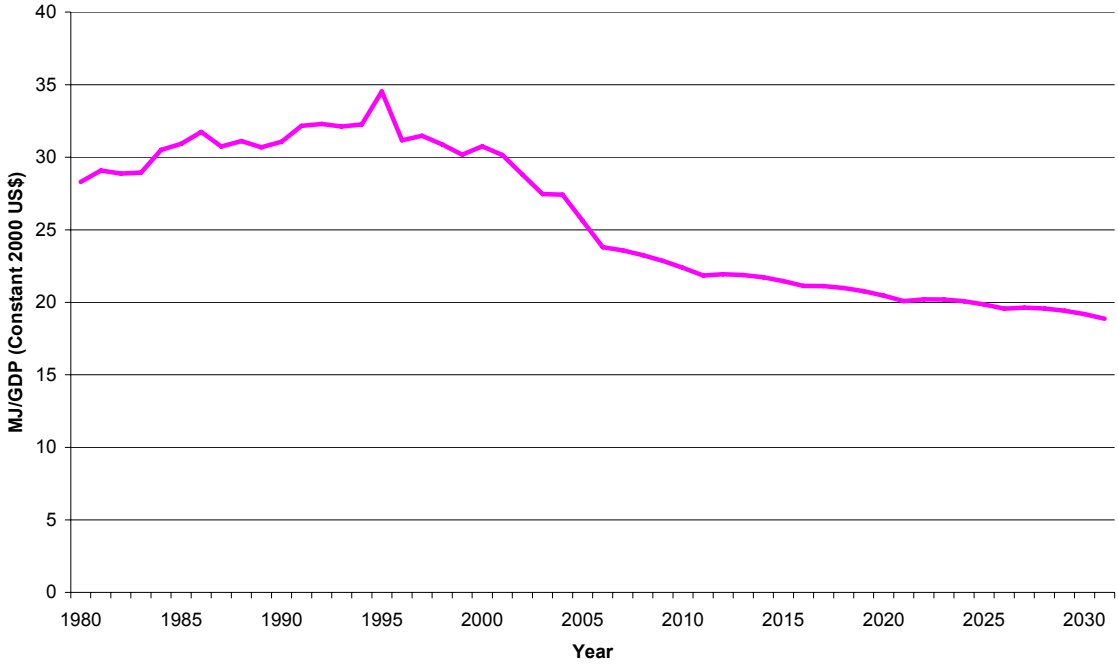
Source: TERI (2006).

g) Total electricity generation



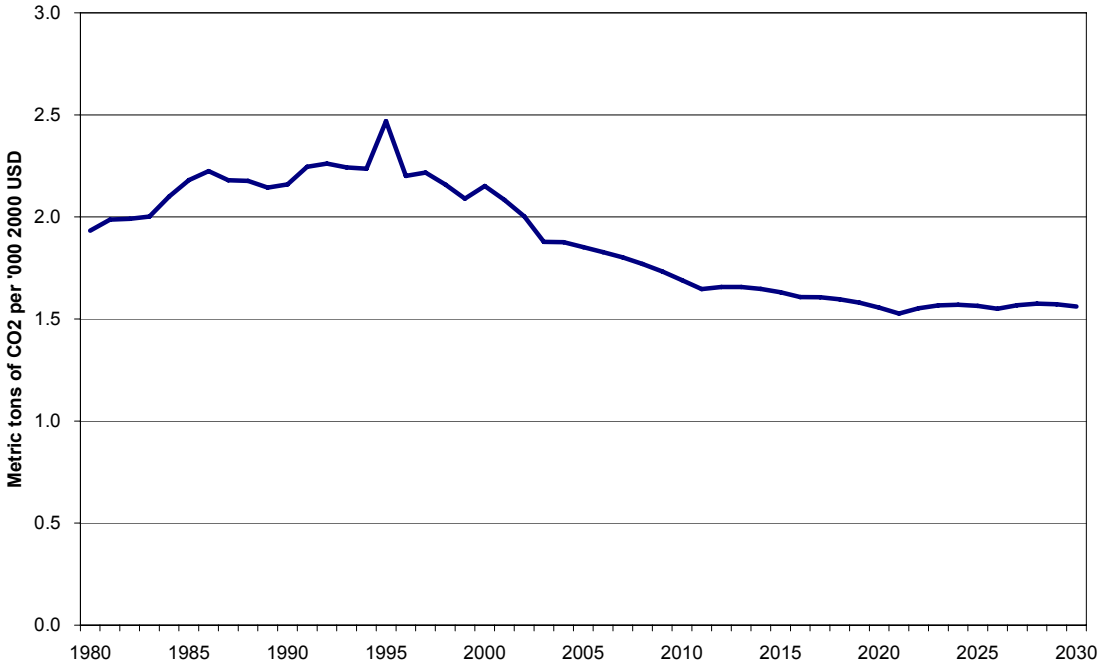
Source: TERI (2006).

h) Energy intensity



Source: EIA (2006), TERI (2006).

i) CO_2 emissions intensity



Source: EIA (2006), TERI (2006).

j) Retail price of various energy sources

Fuel type	Units	1986	1988	1993	1995	2000	2001	2002	2003	2004	2005	2006
Gasoline	cent/liter	16.8	19.4	36.4	40.2	61.9	65.2	65.2	77.3	79.9	97.0	
Steam coal & rubble (F-grade)	cent/kg	0.26	0.37	0.56	0.61							
Slack coal (F-grade)	cent/kg	0.25	0.36	0.54	0.58							
Run-of-mine coal (F-grade)	cent/kg	0.24	0.35	0.49	0.56							
Steam coal & rubble (D-grade)	cent/kg	0.48	0.57	0.87	0.93							
Slack coal (D-grade)	cent/kg	0.46	0.56	0.85	0.90							
Run-of-mine coal (D-grade)	cent/kg	0.46	0.55	0.84	0.89							
NG(off-shore landfall point and on-shore)	US$/ MBTU			1.4	1.5	2.2	2.2	2.2	2.2	2.2	2.3	2.4
NG (North-Eastern States)	US$/ MBTU			0.6	0.6	0.9	0.9	0.9	0.9	0.9	1.0	1.1
Biomass	$/ton		13.1	19.9	19.1							
Diesel	cent/liter	7.9	7.8	13.5	16.4	36.3	40.2	42.6	51.7	53.3	65.2	
Electricity (Household)	cent/KWh	1.06	1.18	1.73	2.11	3.70	3.93					
Electricity (Industry)	cent/KWh	1.49	1.82	3.69	4.57	7.84	7.95					
Electricity (Commercial)	cent/KWh	1.80	2.04	3.82	5.01	8.29	8.58					

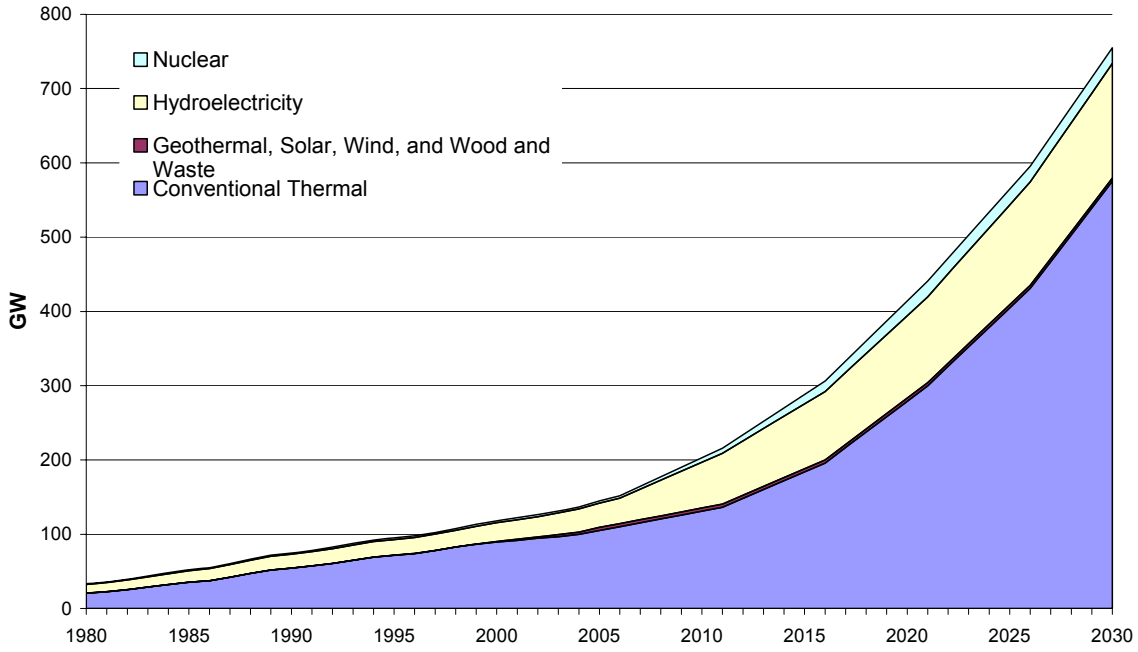
Source: Compiled by ECO-Asia from various sources.

k) Energy reserves status

Energy Reserves (2005)	Total	Proven	Probable	Production	R/P ratio
Coal (million ton) #	247847	92960	154887	305	305
Oil (million barrel) ##	5750	5750		265	22
NG (billion cubic meter)##		1101		33	33

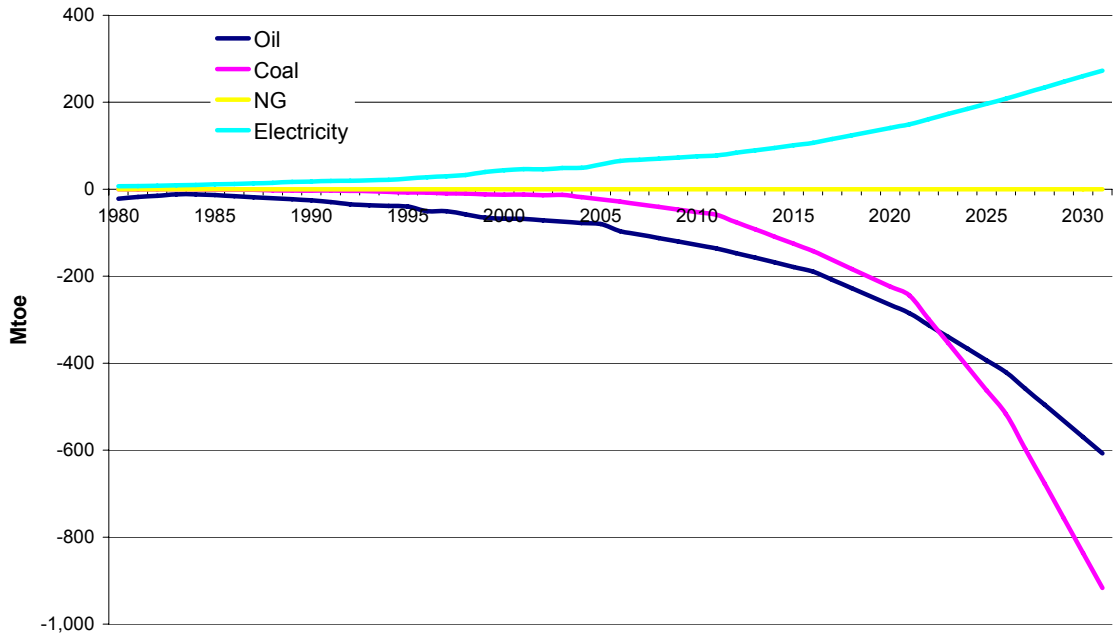
Source: # MOC (2006), ##MOP (2006).

l) Electricity installed generation capacity



Source: TERI (2006).

m) Demand supply gap analysis

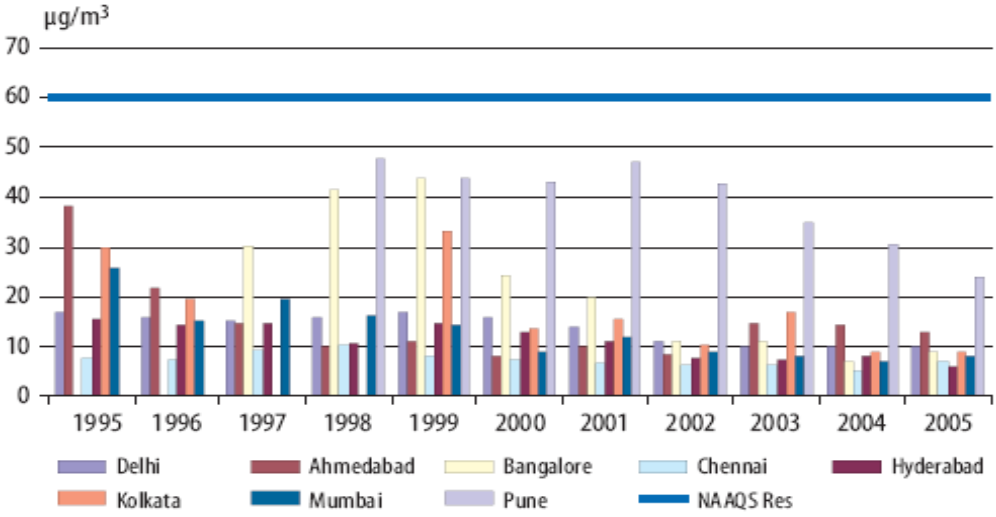


Source: TERI (2006).

Section 3. Environmental impacts related to energy use

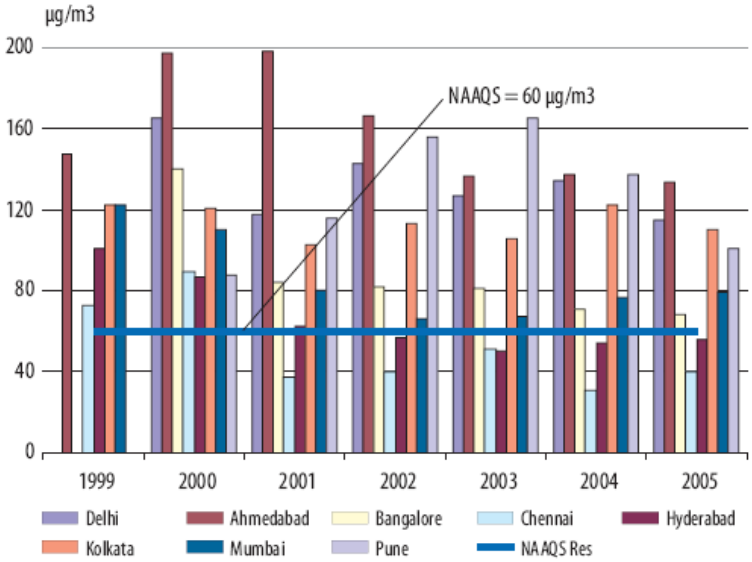
n) Ambient levels

Annual SO_2 Levels in Residential and Other Areas of Eight Major Indian Cities



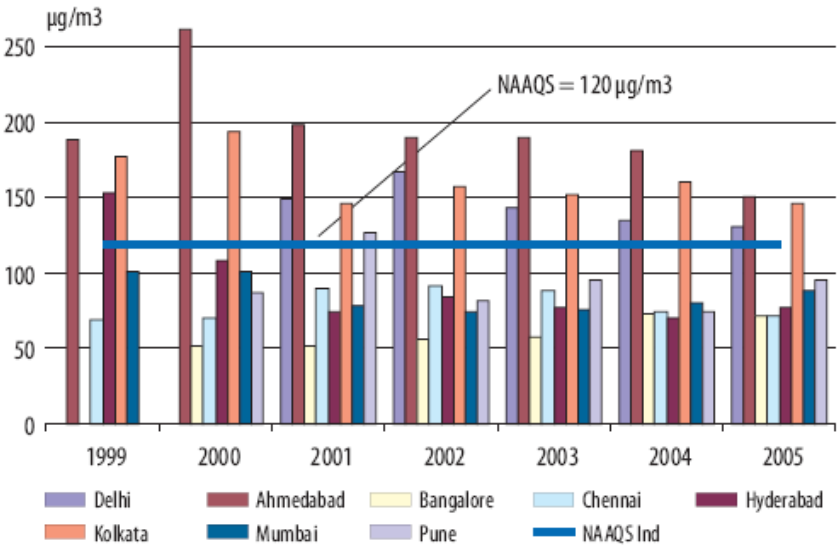
CPCB = Central Pollution Control Board; NAAQS Res = national ambient air quality standard for residential areas; SO_2 = Sulfur dioxide; and ug/m^3 = microgram per cubic meter
Source: CPCB, 2006.

Annual RSPM Levels in Residential and Other Areas of Eight Major Indian Cities



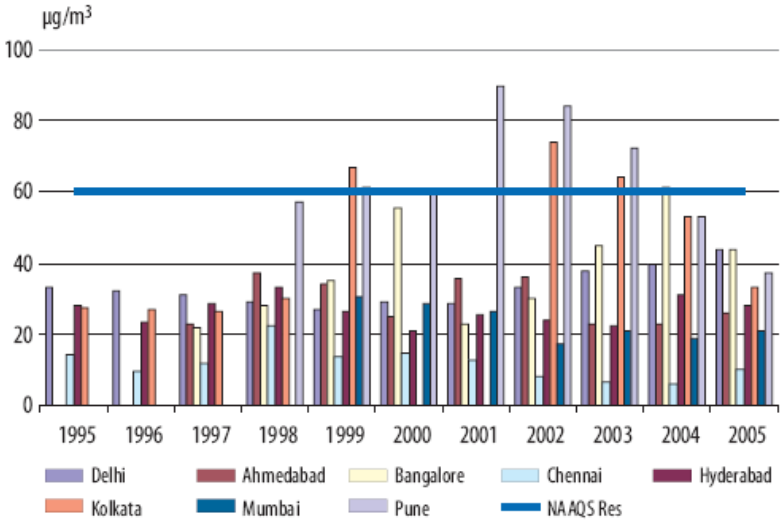
CPCB = Central Pollution Control Board; NAAQS Res = national ambient air quality standard for residential areas; RSPM = respirable suspended particulate matter; and ug/m^3 = microgram per cubic meter
Source: CPCB, 2006.

Annual RSPM Levels in Industrial Areas of Eight Major Indian Cities



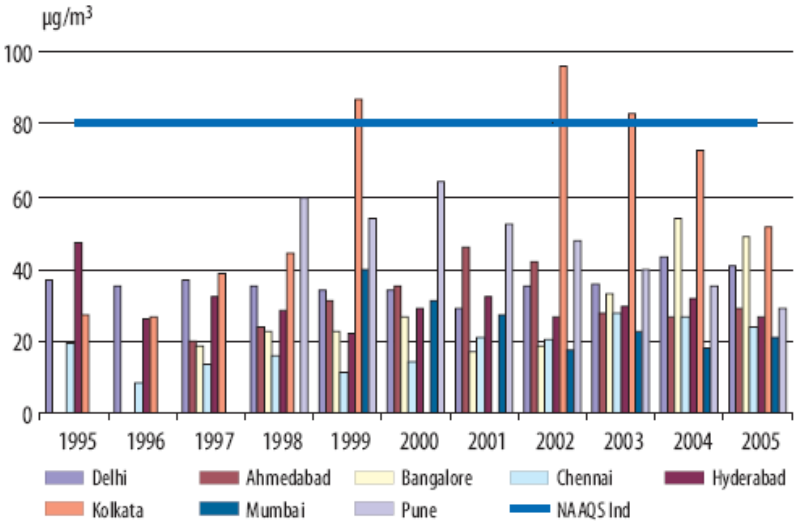
CPCB = Central Pollution Control Board; NAAQS Res = national ambient air quality standard for industrial areas; RSPM = respirable suspended particulate matter; ug/m^3 = microgram per cubic meter
Source: CPCB, 2006.

Annual NO_2 Levels in Residential and Other Areas of Eight Major Indian Cities



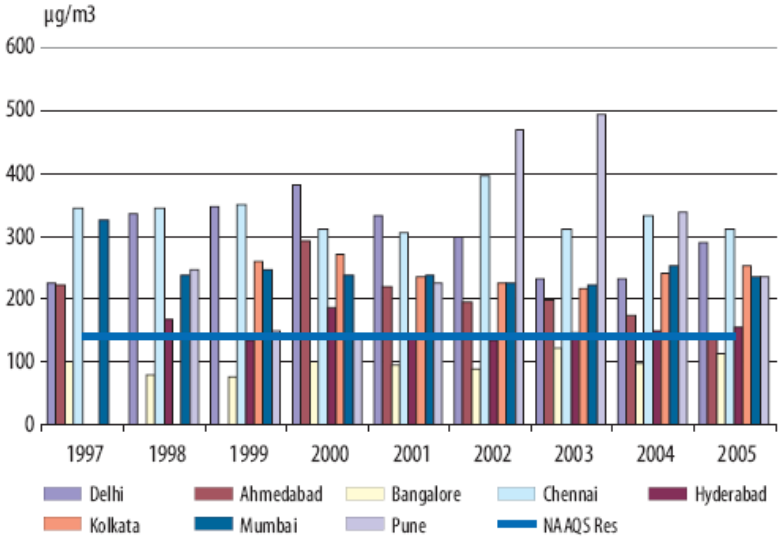
NO_2 = Nitrogen dioxide; NAAQS Res = national ambient air quality standard for residential areas; ug/m^3 = microgram per cubic meter
Source: CPCB, 2006.

Annual NO_2 Levels in Industrial Areas of Eight Major Indian Cities



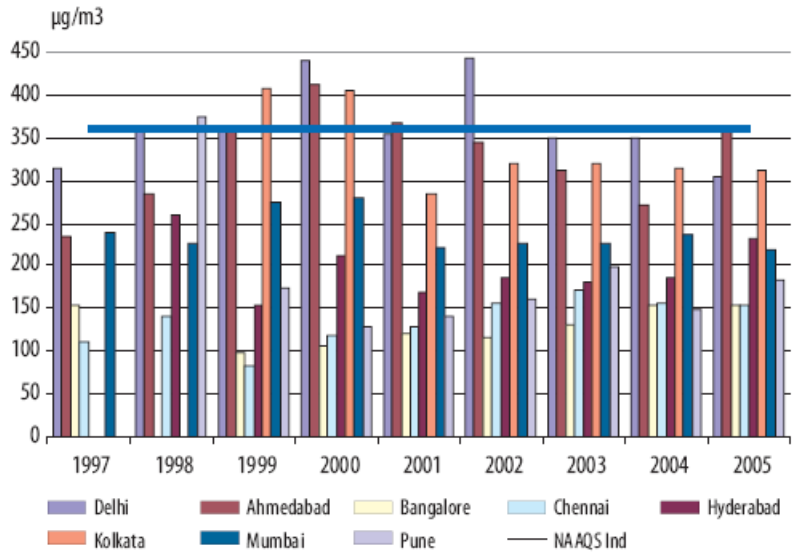
CPCB = Central Pollution Control Board; NAAQS Res = national ambient air quality standard for residential areas; NO_2 = Nitrogen dioxide; and ug/m^3 = microgram per cubic meter
Source: CPCB, 2006.

Annual SPM Levels in Residential and Other Areas of Eight Major Indian Cities



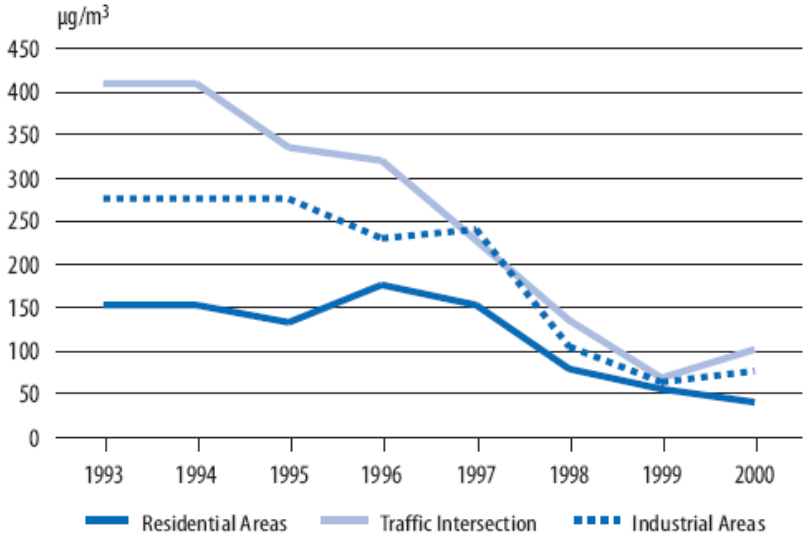
CPCB = Central Pollution Control Board; NAAQS Res = national ambient air quality standards for residential area; SPM = suspended particulate matter; and ug/m^3 = micrograms per cubic meter
Source: CPCB, 2006.

Annual SPM Levels in Industrial Areas of Eight Major Indian Cities



CPCB = Central Pollution Control Board; NAAQS Res = national ambient air quality standards for industrial areas; SPM = suspended particulate matter; and ug/m³ = micrograms per cubic meter
Source: CPCB, 2006.

Annual Ambient Lead Concentrations in Delhi



ng/m³ = nanograms per cubic meter
Source: Sengupta, 2004.

Notes:

Lead: A substantial decrease in the ambient levels of lead was observed since introducing low leaded gasoline in the city. Lead in gasoline has been decreased from 0.56g/l in 1994 to 0.15g/l in 1997 and completely phased out in 1998 (SASEC 2005).
Ozone (O_3): Ambient ozone concentrations in Delhi have been within WHO (2006 update) limits of 100µg/m^3 with some occasional peaks above the guideline values. The values ranged from 32–104µg/m^3 in 1998, 26–82µg/m^3 in 1999, 10–77µg/m^3 in 2000, 10–130µg/m^3 in 2001, and 10–65µg/m^3 in 2002

Source: ADB (2006).

o) Comparison of India's NAAQS with WHO and US EPA

Air Pollutant	Time-weighted Average	India ($\mu g/m^3$)[a,b]			WHO[c] ($\mu g/m^3$)	US EPA July 1997 ($\mu g/m^3$)
		Industrial	Residential	Sensitive		
NO_2	Annual	80.00	60.00	15.00	40.00	100.00
	24 hours	120.00	80.00	30.00		
SO_2	Annual	80.00	60.00	15.00	50.00	80.00
	24 hours	120.00	80.00	30.00	20.00	365.00
CO	8 hours	5000.00	2000.00	1000.00	10,000.00 (d)	10000.00
	1 hour	10000.00	4000.00	2000.00	30,000.00 (d)	40000.00
Pb	Annual	1.00	0.75	0.50	0.50 (d)	1.50
	24 hours	1.50	1.00	0.75		
PM_{10}	Annual	120.00	60.00	50.00	20.00	
	24 hours	150.00	100.00	75.00	50.00	150.00
SPM	Annual	360.00	140.00	70.00		
	24 hours	500.00	200.00	100.00		
NH_3	Annual		100.00			
	24 hours		400.00			

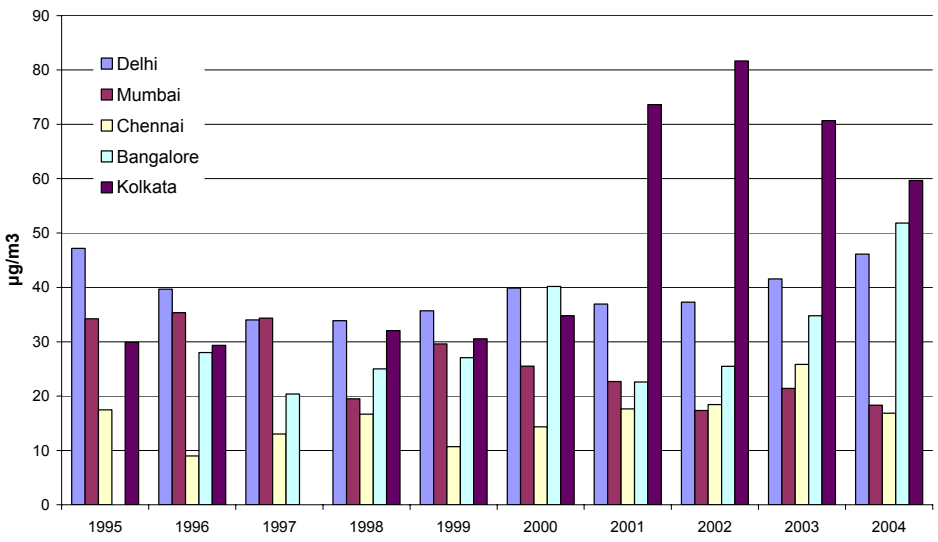
CO = Carbon monoxide; NAAQS = national ambient air quality standard; NH_3 = ammonia; NO_2 = Nitrogen dioxide; Pb = lead; PM_{10} = particulate matter with diameter less than 10 micrograms; SO_2 = Sulfur dioxide; SPM = suspended particulate matter; US EPA = Unit

[a] Annual average of minimum of 104 measurements in a year, taken twice a week, 24-hourly uniform intervals.
[b] 4-hourly/8-hourly values should be met 98% of the time in a year, it could exceed 2% of the time but not on 2 consecutive days. [c] WHO 2006. [d] WHO

Source: ADB (2006).

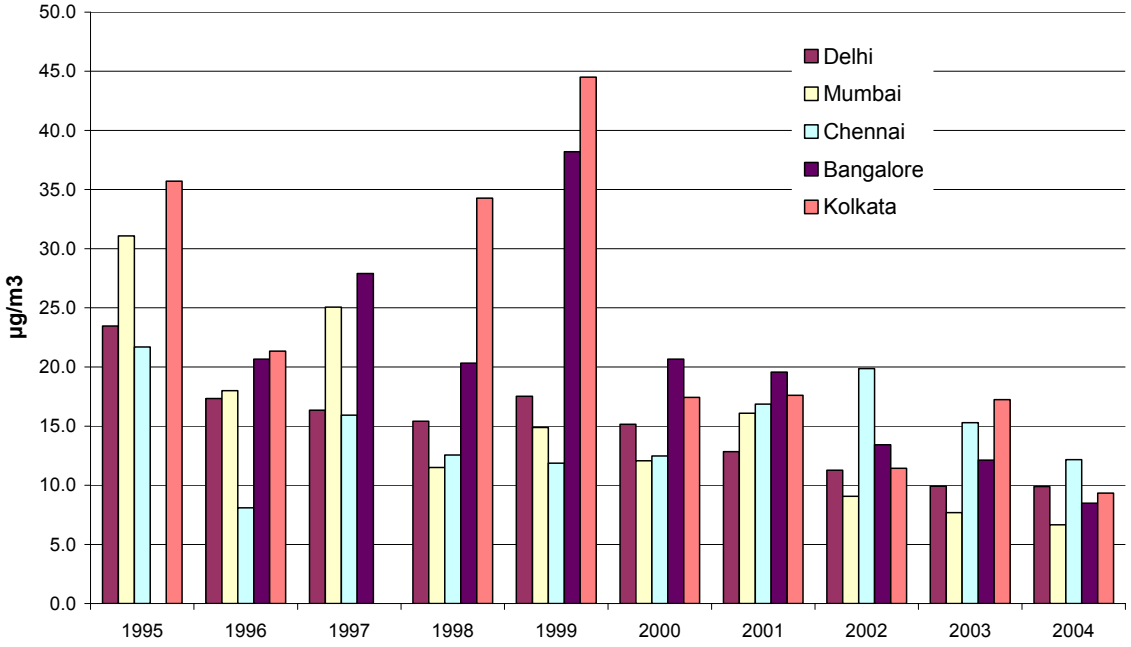
p) Ambient levels

a. NOx



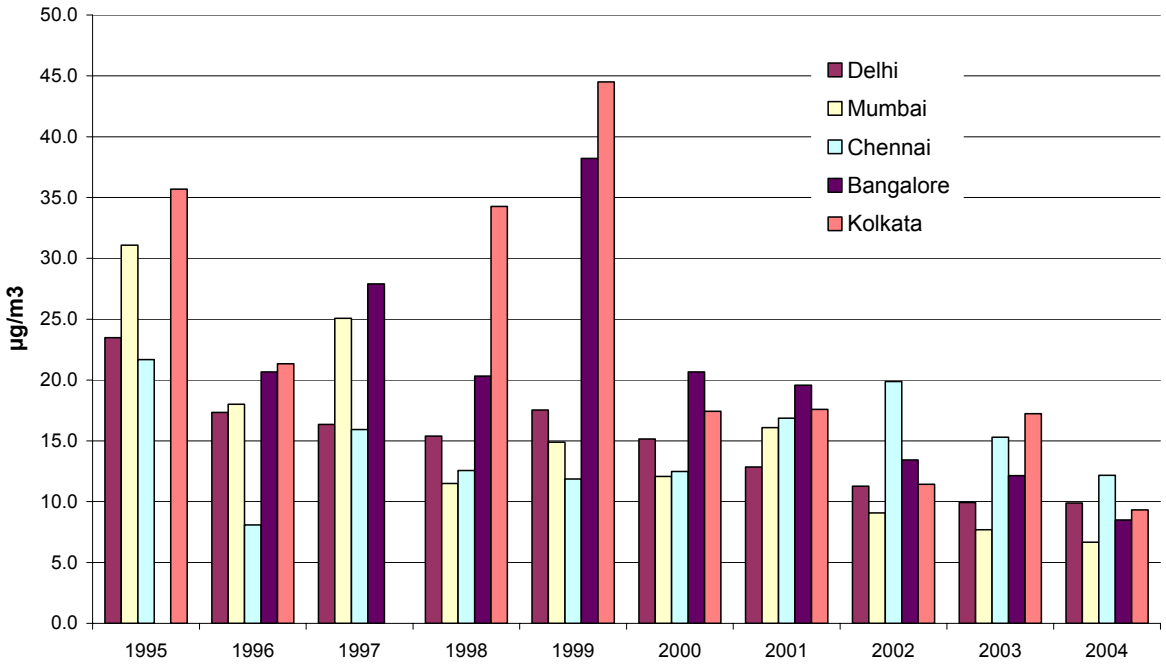
Source: CPCB (2006).

b. SO_2



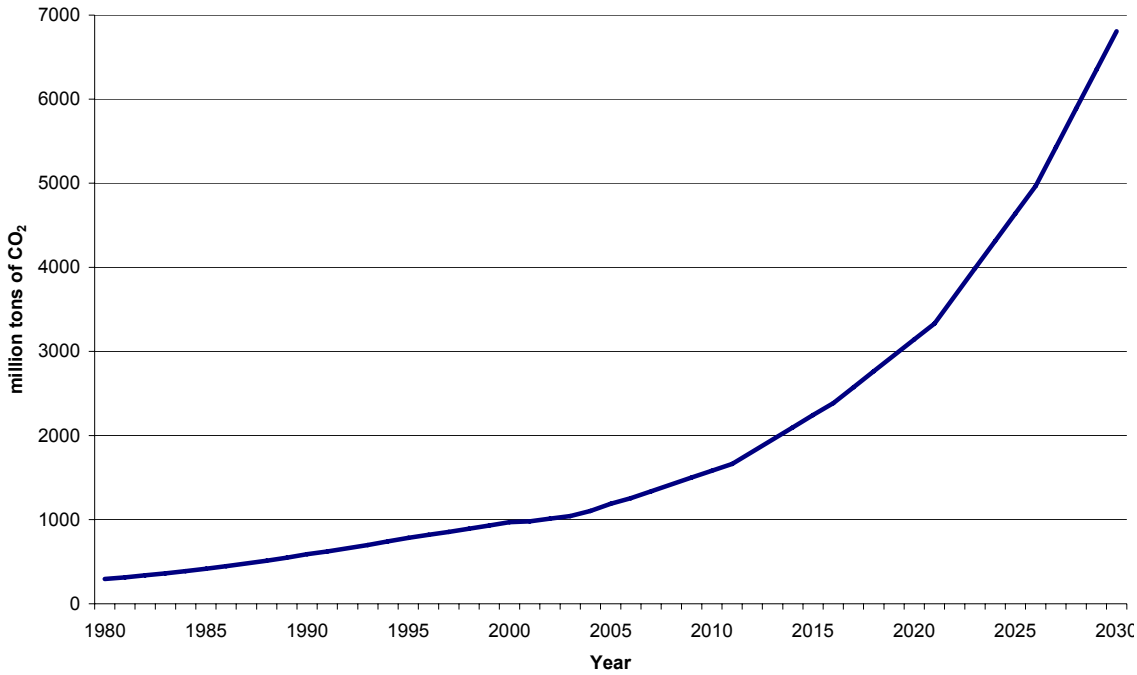
Source: CPCB (2006).

c. SPM



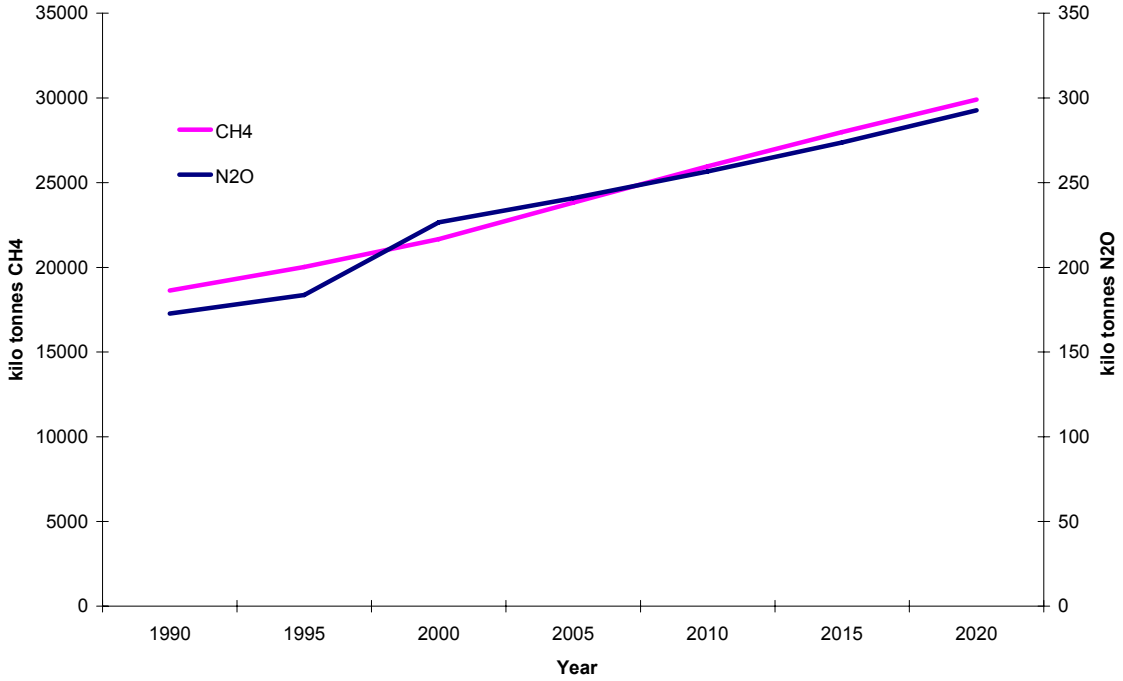
Source: CPCB (2006).

q) CO_2 emissions



Source: TERI (2006).

r) Emission of other GHGs



Source: EPA (2006).

s) National aggregate emission of other gases

Type emission	1985	1990	1995	2000	2005	2010	2020
NO_X (kilo tonnes)	2110	2640	3460	4310	5020	6080	7640
SO_2 (kilo tonnes)		3540	4640	5580	6020	6460	8090
CO (kilo tonnes)	33700	35100	37200	40300	41700		
TSP (kilo tonnes)	8120	9210	10130	9130	8720		

Source: TERI(2006).

Section 4. Clean energy outlook

t) Renewable energy outlook table

	Potential (MW)	Installed (MW) (2006)	Generation Cost (INR/KWh) #
Wind	45000	5340	3-4
Biomass	16000	447.4	3-4
Bagasse Cogeneration	3500	502.03	2-3
Solar Thermal (million m2 collector area)	140	0.8	
Solar PV	20 MW/km2	2.8	15-20
Geothermal			
Small Hydro	15000	1826.4	2.5-3.5
Biodiesel	10 million tons per year	1.8 million liters per year	25
Ethanol	20 million ton per year	2074.5 million liters per year	
Biogas	5000 ##	45.98	4-7.5

Source:MNRE, # IPCR (2006), ## TERI (2006).

u) Energy Efficiency outlook

Targeted Energy Savings*

	GWh	MW
Industrial	49,056	7,000
• Generic EE projects	23,827	3,400
• Process-specific EE projects	25,229	3,600
Commercial	4,439	1,935

*The total target for all sectors is 95,000 GWh, which is estimated at 13% of total demand.

Source: ADB (2006b).

v) Positive impacts by deployment of clean energy technologies (1998)

Technology	Greenhouse gas emissions reduction	Investment cost	Cost-effectiveness (dollars/tonne CO_2)
Small hydro	1.3 kg/kWh	1950 dollars/KW	88
Wind farms	1.3 kg/kWh	1405 dollars/kW	257
Biomass	1.6 kg/kWh	710 dollars/kW	102
Solar thermal	1.3 kg/kWh	3730 dollars/kW	592
Solar PV (photovoltaic)	1.6 kg/kWh	5952 dollars/kWp	541

Source: TEDDY 2003-04.

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